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TECHNICAL NOTE

AN APPARATUS FOR THE ASSESSMENT OF THE REINFORCING PROPERTIES OF ODORS IN SMALL ANIMALS[1]

Research on olfaction has sought mainly to: (1) determine the nature of the receptor process, and, (2) evaluate the functional modes of operation of the olfactory system. Numerous experiments have studied the first problem (Wenzel and Sieck, 1966), but the evaluation of the role of olfaction in regulating behavior has been limited by the fact that it is difficult to control presentation of odors to animals, thus making it difficult to assess their behavioral effects.

Though it is ultimately necessary to achieve accurate control of odors, it would be superfluous without the technological capacity to assess independently the amounts of odorous materials. At present, such techniques are limited by the prohibitive costs and necessary technology. Indeed, it is probable that the nose is more sensitive to variations in odors than most of the devices currently available for measuring them (Turk, 1964). At present, research on the functions of the olfactory system can best proceed by investigating the effects of the controlled presentation of known amounts of odorous substance relative to some control condition.

This report describes an apparatus developed for the delivery of olfactory stimuli to small animals. Numerous modifications of this equipment are possible to broaden its general application. The equipment was developed for the specific purpose of assessing the reinforcing properties of odors. The use of a two-choice operant situation allows the assessment of the relative behavioral effects of two response-contingent stimuli. Since only one of the sources of stimulation includes a known odor-producing substance, the non-odorized source maintains a background level of behavior for the purpose of comparison.

Components

The basic apparatus consists of a 12 by 9 by 15-in. Plexiglas box with two 1-in. by 3-in. levers situated at opposite ends 1.5 in. above a grid floor. To allow for maximum air flow, both the top and bottom of the box are left open except for the grid floor positioned 2 in. above the lower edge. The problem of animals jumping out has not been encountered, but it could be overcome by positioning a removable grid at the top.

The levers are mounted on relay contact assemblies and are virtually silent in operation. The tension springs on the relay assembly can be adjusted to vary the force necessary to close the contacts. In most studies, the lever has been adjusted to move through a distance of 4 mm when a force of 25 g is applied.

The Plexiglas box is mounted inside a ventilated, light-proof, sound-insulated cabinet that can be coated with Teflon film. Ventilating air enters and exits the cabinet via 6-in. sheet metal ducts (stove pipe) connected to the building ventilation system. The overall arrangement is depicted in Fig. 1. Air flow is facilitated by small rheostatically controlled fans placed in the input and exhaust pipes at their entrance and exit to the cabinet. Since the system is open, the fan in the input pipe provides some assurance that odor entering the cabinet is not contaminated by room odors, which might be drawn in around the door if only an exhaust

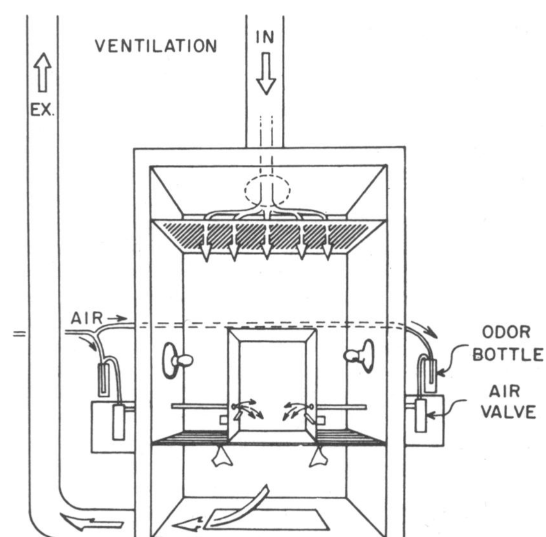

Fig. 1. A schematic diagram showing the flow of air used for delivering the odor. The outer shell represents the cabinet. The grid floor of the Plexiglas box is not shown.

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[2]Reprints may be obtained from Charles J. Long, Department of Psychology, Memphis State University, Memphis, Tennessee.

fan were used. Placing the exhaust fan below the animal minimizes eddying as well as possible contamination of the odors from animal excrement, which collects below the Plexiglas box. Air conditioner filters placed below the input fan diffuse the flow of air so that it passes evenly throughout the box. This also allows for the ventilating air to be filtered through activated charcoal and silica gel before passing through the subject compartment.

The rate of air flow through the box may be varied over a wide range by adjusting the fan speed. Good results have been obtained at a rate that clears the refrigerator cabinet every 24 sec. The rate of flow was measured by a Hastings air-meter (Model AM-12 Hastings-Raydist Inc., Hampton, Va.) At this setting, the air moves evenly through the Plexiglas box at a rate of 2 in. per sec; thus, the odor-laden air is cleared from the box within 1 sec, since it enters only 1.5 in. above the floor.

Odors enter the Plexiglas box through a 0.25-in. Tygon tube 1 in. above the levers (see Fig. 1). The air that carries the odor comes from a compressed air line supplying the building and is regulated to 2 psi by a DeVilbiss (Type HE-502) pressure regulator (The DeVilbiss Co., Toledo, Ohio.) The volume of air is controlled by Skinner electric valves (No. V5-750 Herbach and Rademan Inc., Philadelphia) located immediately outside the cabinet and sound insulated to minimize operation noise. The apparatus is wired so that depressing a lever opens its valve and allows the air to flow into the apparatus. The duration of the air puff can be predetermined or contingent on the duration of the lever-press. A 1-sec duration was found to be the mean response duration for animals in a non-timed procedure, so this duration has been standardized. The electric valves delivered 50 ml of air in 1 sec. The volume was determined by accurately adjusting the duration of solenoid closure to 1 sec and then measuring the volume of water displaced in a filled and inverted graduated cylinder. For future use, a Manostat flowmeter (No. 36-541 Manostat Corp., New York, N. Y.) has been calibrated by this method. Odorized air is introduced between the source of air and the electric valve (see Fig. 1).

In the experiments conducted thus far, odor has been delivered by passing the air through a 1500-cc screw-top wash bottle that contains a small amount of the odor-producing material; thus, the vapor from the wash bottle carries the odor from the substance in the bottle. The size of the bottle and the exit port minimize the possibility of particulate matter passing into the subject compartment. The air in the bottle represents a reservoir of odorized air that is continually replenished. It can thus be assumed that the air carrying the odorous materials is maximally saturated for the particular temperatures and pressures employed. The delay between the presentation of the odor and the animal's response is minimal, since after the flow of odorous air, the line is closed and still contains odorous air that will be presented after the next lever-press. The air lines need to be cleared only when changing subjects or odor position. In studies where more rigorous control of the volume of odorous air is required, a procedure similar to that utilized by Tucker (1963) has been adapted to this system.

Although the apparatus has been designed for the controlled presentation of odors, it is quite easily adapted to a variety of problems. We have mounted 3-in. speakers below the levers and 7.5-w light bulbs on the outside of the apparatus for the presentation of sound and light changes (see Fig. 1). The grid floor could be wired for shock for negative reinforcement and a variety of positive reinforcers could be delivered into the apparatus with minor modifications.

Operation

The apparatus has been used with rats in a variety of testing procedures designed to investigate the reinforcing properties of odors. Testing consists of placing the animal in the apparatus and counting the number of responses on each lever. On one lever the animal received 50 ml of odorized air for each lever-press. The other lever served as a control, and the animal received 50 ml of air passed through an empty wash bottle.

Sample data

Figure 2 shows the performance of 16 adult, male, albino rats in a typical experiment. All subjects were adapted to a food-deprivation schedule for 14 days and then tested in the apparatus every third day. On non-test days they remained in their home cages and were fed on schedule. On test Day 1, non-odorized air was presented when a subject pressed either lever. On test Days 2 and 3, 50 ml of powdered food and 50 ml of water were mixed in one of the odor bottles, which was placed on the side with the lever each subject least preferred as indicated by Day 1 performance. Each testing session lasted 60 min. The subjects showed a marked preference for the odorized air. Fifteen of the 16 subjects exhibited this preference on Day 2, and all 16 subjects preferred the odorized air on Day 3. Similar results have been obtained with the odor of amyl acetate (Long and Tapp, 1967) and methyl salicylate. These experiments indicate that certain odors can serve as reinforcing stimuli and that this apparatus can

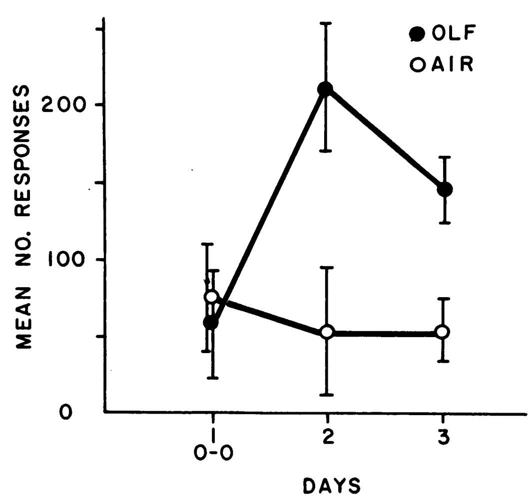

Fig. 2. Representative data collected. The odor was provided by wet mash made from equal parts of water and powdered rat chow. The standard error of the difference is shown by the vertical line.

be used to study the reinforcing properties of olfactory stimuli.

REFERENCES

Long, C. J. and Tapp, J. T. Reinforcing properties of odors for the albino rat. *Psychon. Sci.*, 1967, **7**, 17-18.

Tucker, D. Physical variables in the olfactory stimulation process. *J. gen. Physiol.*, 1963, **46**, 453-489.

Turk, A. Approaches to sensory odor measurement. *Ann. N. Y. Acad. Sci.* 1964, **116**, 564-566.

Wenzel, B. B. and Sieck, M. H. Olfaction, *Annu. Rev. Physiol.*, 1966, **28**, 381-434.

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